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Demonstration and Evaluation of Visual Display Technologies for Travellers with Hearing and Cognitive Disabilities

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Demonstration and Evaluation of Visual Display Technologies for Travellers with Hearing and Cognitive Disabilities

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March 2003

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16. Abstract

Text display technologies are helpful for persons who cannot hear or effectively comprehend public announcements or boarding information in airports. For this project several text display technologies were demonstrated and evaluated with subjects at Ottawa International Airport. Four types of text display technologies were tested: electronic reader board, full screen text on a gate monitor and a terminal monitor, and open captioning on a Flight Information Data monitor.

After the demonstration the technologies were assessed for usability, functionality, effectiveness and technical feasibility. Participants who were hard of hearing or deaf, or who had cognitive disabilities tested the technologies in a setting similar to real conditions (i) at the waiting lounge of an Air Canada gate counter, and (ii) in a public waiting area in the terminal. The test methodology included observations, formal questionnaires and discussions with the participants.

The results indicated that the electronic reader board provided the most effective display, followed by text display on monitors. It is recommended that an in-service demonstration program be devised that would monitor these technologies in several airports and evaluate their performance.

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16. Resumé

Les afficheurs de textes sont utiles pour les personnes qui ne peuvent entendre correctement les messages sonores ou les informations relatives à l'embarquement diffusées dans les aéroports. Dans le cadre de ce projet, de nombreux systèmes d'affichage ont fait l'objet d'une démonstration et d'évaluations auprès de voyageurs en transit à l'Aéroport international d'Ottawa. Quatre types de systèmes d'affichage ont été mis à l'essai, soit un tableau d'affichage électronique, un système d'affichage plein écran installé dans l'aérogare et aux portes d'embarquement et un écran d'information sur les vols sur lequel défilaient des sous-titrages visibles.

Au terme des démonstrations, les différents systèmes ont été évalués en fonction de leur convivialité, fonctionnalité, efficacité et faisabilité technique. Tous les systèmes ont été mis à l'essai par des participants qui étaient soient sourds, malentendants ou qui souffraient de troubles cognitifs. Ces essais se sont déroulés dans des conditions semblables à celles qui existent (i) dans l'aire d'attente d'une porte d'embarquement d'Air Canada, et (ii), dans l'aire d'attente publique de l'aérogare. Pour la tenue des essais, la méthode utilisée s'articulait autour d'observations, de questionnaires officiels et de discussions avec les participants.

Les résultats obtenus indiquent que le tableau d'affichage électronique constitue le meilleur système d'affichage, suivi du système d'affichage de messages textuels sur les écrans de l'aérogare. On propose d'élaborer un programme de démonstration interne qui permettrait de mettre ces systèmes à l'essai dans plusieurs aéroports et de les évaluer en fonction de leur efficacité.

17. Mots clés	18. Diffusion
Systèmes d'affichage, système de messagerie visuelle, tableau d'affichage électronique, écran installé à la porte d'embarquement, écran d'information sur les vols, sous-titrage visible, surdité, déficience auditive, troubles cognitifs, communications à l'intérieur de l'aérogare	Le Centre de développement des transports dispose d'un nombre limité d'exemplaires.

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Executive Summary

"The airline agent at the gate snatches her boarding pass and tells her, most indignantly, that she should have been there a half-an-hour ago as the announcement instructed. The passenger does not respond, but only smiles. She has heard nothing. She is deaf!" ("Information to Go!", Moving Ahead, Canadian Transportation Agency, Spring 2002)

Several studies in Canada have addressed the incidence of disabilities amongst the Canadian population. It is estimated that of the 2.9 million persons with transportation disabilities in Canada in 1995, 715,000 travel by air. Of these, 31.7 percent have hearing problems and 23.7 percent have other problems (not including mobility, agility, seeing, or speaking). Persons over the age of 65 who typically can develop hearing problems, and persons who have cognitive problems are expected to increase to 7.8 million in 2025.

In transportation terminals, travellers who are deaf or those with severe hearing disabilities may not receive public audio messages. Travellers with cognitive disabilities and many elderly persons may not receive an audio message clearly enough to respond. When hearing or comprehension is impaired, there is an increased dependence on other sensory information, particularly visual information. Both groups need an alternative message mode. Not reaching those who cannot hear the audio message could result in severe consequences for the person's safety, leaving a person stranded or missing some important flight information.

The objective of the study is to demonstrate and evaluate the most effective technologies for communicating messages to persons with hearing or cognitive disabilities in airport terminals. The project successfully achieved this objective.

As a first step, text display technologies were selected based on feedback from associations representing persons who are hard of hearing, persons who are deaf, and persons with cognitive disabilities. In addition, data from literature and the Internet were used to narrow the number of technologies applicable in an airport environment. Human factors characteristics of the target group were analysed to verify which of the technologies would best serve their needs.

The following technologies were selected for a demonstration at Ottawa International Airport:

- Text display on existing electronic reader board at an Air Canada gate counter;
- Full screen text display on a video monitor at the gate's waiting lounge;

- Open captioning on the airport's Flight Information Data (FID) monitors for general purpose information within the terminal; and
- Full screen text display on a stand-alone monitor within the terminal.

To carry out the demonstration, a test methodology was developed with the following characteristics:

- Individuals who are hard of hearing or deaf, as well as persons with cognitive disabilities were recruited;
- Text displays were developed and mocked-up;
- Data collection tools were designed; and
- Test scenarios were designed for each target group to test each technology.

The test methodology included observations, formal questionnaires and discussions with the participants. Over a period of three days, three groups consisting of three individuals each were tested with the selected technologies. The airport settings were as real as possible at the gate's waiting lounge without interfering with the airline's regular operations. Audio announcements were simulated by an Air Canada agent at the gate, and by an agent at the information booth in the terminal.

The results of the demonstration indicated that:

- Visual messaging systems can alleviate some specific information problems faced by the travelling public, particularly for those persons with hearing and cognitive disabilities. Increased independence and confidence could result from the knowledge that important information will be presented in a medium that is an alternative to audio.
- At present airport/airline staff do not always adequately communicate with the target group.
- The electronic reader board at the gate and the visual paging monitor in the terminal were considered the most effective display technologies. Displays on the FID monitor in the terminal and the text monitor at the gate were considered almost as effective as the former two.
- The "broken ear" symbol on monitors was found useful for participants with hearing impairments since it attracted their attention.
- The placement, number and location of display units in a waiting area is critical for effective usage. Text type, size and colour (e.g., white or yellow letters on blue or black background), glare-free surfaces and display times all contribute to the effectiveness.

- The flashing cursor on the reader board was found distracting and annoying. The last line of the board for additional messages is located too low and can be obstructed by standing passengers or attendants.
- Message display time should be longer.
- Participants should be made aware initially of the existence and the location of text display systems in the airport and at the gates.
- The content of the displayed message should provide complete information. "Flight cancelled" left the question open of what the passenger should do.
- The comprehension of audio messages provided over the public announcement system was difficult. It may depend on the announcer's voice pitch and/or speed, the environmental noise, technical qualities of the systems and airport acoustics.

On the technical side, currently used electronic reader boards at gates provide a technology that can easily be used to display additional text information without any modification to the system. The display of English and French text can be achieved by alternating text between the two languages on the last line. At the present time, monitors for real-time text display are not in use at gates or in the terminal, but the technology and input devices are available as off-the-shelf components. To set up a system at the gate, installation of monitors, hardware and software would be required. To do the same for the terminal, the system must be accessible by various participants in the airport, e.g. airlines, airport, security, information, etc. Text display on FID monitors is currently not feasible due to restrictions for their use in airports.

At the moment, the operation of electronic reader boards is carried out by a gate agent and would require an additional 15 to 20 seconds of input time per message. The same time is anticipated for message input to monitors.

Based on these conclusions, the following recommendations are proposed:

- Use the reader board's last line for text display in addition to audio gate public announcements that would improve boarding information for many passengers, especially those with hearing and cognitive disabilities. Where reader boards are not available, text display on monitors may be used.
- Add the broken ear symbol to text display messages and determine size, colour and type according to international standards and ergonomic principles.
- Determine the number and location of display units at gate waiting lounges, and place them in locations free of competing visual information.

- Reduce the size of the cursor on the reader board and eliminate the flashing. Mount the reader board higher with the last line above the head height of a standing 95 percentile male. The last line must be readable from any potential viewing point within the waiting area.
- Determine the length of text display time. For text displays in a terminal, minimum display times should be determined, especially when several airport participants want to display at the same time, e.g. airlines, airport, security, information, etc.
- Promote awareness of the text display systems, i.e. airlines, airports, associations for the disabled, and other relevant media.
- Prevent ambiguous messages by displaying complete message, e.g. "Flight is cancelled, report to agent".
- Improve the voice pitch and message speed for public announcements in terminal and at departure gates. Improve general acoustics and decrease environmental noise levels.
- Develop an in-service demonstration program in cooperation with the airlines to monitor and evaluate text displays at departure gates where reader boards are available, and use full screen text for monitors.

Sommaire

«L'agent de la ligne aérienne lui arrache sa carte d'embarquement, notant d'un air très indigné qu'elle aurait dû être là il y a une demi-heure comme on l'avait annoncé. La passagère ne répond pas, elle ne fait que sourire. Elle n'a rien entendu, car elle est sourde!» («Information pour tous!», *On va de l'avant*, Office des transports du Canada, printemps 2002).

De nombreuses études réalisées au Canada ont traité de l'incidence des incapacités chez les Canadiens. On estime que des 2,9 millions de Canadiens qui avaient de la difficulté à voyager en 1995, 715 000 ont emprunté les lignes aériennes. De ce nombre, 31,7 p. 100 étaient atteints de troubles auditifs et 23,7 p. 100 souffraient d'un autre handicap (excluant les troubles de motricité, d'agilité, de la vue ou de la parole). On s'attend à ce que le nombre de personnes de 65 ans et plus sujettes aux troubles auditifs, et les personnes souffrant de troubles cognitifs, grimpera à 7,8 millions en 2025.

Dans les gares terminales, il est possible que les voyageurs atteints de surdité ou de déficiences auditives graves n'entendent pas les messages transmis par le système de sonorisation. Il se peut également que des personnes âgées ou des voyageurs atteints de déficiences cognitives n'entendent pas clairement les messages sonores. Étant donné que les personnes atteintes de déficiences auditives ou cognitives mettent à profit leurs autres sens, particulièrement la vue, elles doivent pouvoir compter sur des systèmes de messagerie auxiliaires, sans quoi leur sécurité pourrait être compromise. Ces personnes pourraient alors être malencontreusement retenues dans l'aérogare ou pourraient ne pas prendre connaissance de certaines informations de vol importantes.

Cette étude vise à démontrer et évaluer des systèmes d'affichage dans le but de déterminer celui qui permet de communiquer le plus efficacement possible des messages aux voyageurs atteints de déficiences auditives et cognitives qui sont en transit dans les aérogares. Le projet a atteint cet objectif avec succès.

Au cours de la première étape, les systèmes d'affichage ont été choisis en fonction des commentaires formulés par des associations représentant des personnes atteintes de déficiences auditives et cognitives. On a également eu recours à Internet et à des données tirées de la documentation pour restreindre le nombre de systèmes applicables à un environnement aéroportuaire. Les caractéristiques et les facteurs humains des groupes cibles ont été analysés afin de vérifier les technologies qui conviendraient le mieux à leurs besoins.

Les systèmes suivants ont été retenus pour un essai à l'Aéroport international d'Ottawa :

- Tableau d'affichage électronique installé au comptoir d'une porte d'embarquement
  d'Air Canada;
- Système d'affichage plein écran installé dans l'air d'attente de l'aérogare;
- Utilisation des écrans d'information sur les vols pour afficher des sous-titres visibles et présenter des informations de nature générale dans l'aérogare;
- Utilisation d'un écran autonome installé dans l'aérogare pour l'affichage de messages plein écran.

La méthode adoptée pour la tenue des essais est la suivante :

- Recrutement de personnes atteintes de déficiences auditives, de surdité et de troubles cognitifs;
- Mise au point de maquettes et des systèmes d'affichage textuels;
- Conception d'outils de collecte de données;
- Élaboration de tests pour chaque groupe cible visant la mise à l'essai de chaque système.

La méthode adoptée pour la tenue des essais s'articulait autour d'observations, de questionnaires officiels et de discussions avec les participants. Au cours d'une période s'échelonnant sur trois jours, trois groupes formés de trois personnes ont testé les systèmes d'affichage retenus. On a tenté de recréer des paramètres se rapprochant le plus possible de la réalité, sans pour autant interférer avec les activités régulières de l'aéroport. Des messages sonores ont été simulés par un agent d'Air Canada à la porte d'embarquement et au comptoir d'information de l'aérogare.

Les résultats de cette démonstration ont indiqué que :

- Les systèmes de messagerie visuelle peuvent permettre de régler certains problèmes de transmission d'informations auxquels sont confrontés les voyageurs, particulièrement ceux qui sont atteints de déficiences auditives et cognitives. Ces systèmes pourraient améliorer leur autonomie et leur confiance en sachant que les informations importantes sont diffusées sur des systèmes autres que les systèmes de sonorisation.

- Actuellement, les employés des aéroports et des transporteurs aériens ne communiquent pas toujours de façon adéquate avec les membres des groupes visés.
- De l'avis des participants au projet, le tableau d'affichage électronique installé à la porte d'embarquement et le système de téléavertissement visuel de l'aérogare sont considérés comme les systèmes d'affichage les plus efficaces. Viennent ensuite, non loin derrière, l'écran d'information sur les vols et l'écran d'affichage de textes installés dans l'aérogare et à la porte d'embarquement, respectivement.
- Les participants sont d'avis que le symbole international de déficience auditive (oreille avec une barre transversale) est utile puisqu'il attire l'attention des personnes qui sont atteintes de déficiences auditives.
- L'efficacité des dispositifs d'affichage dans l'aire d'attente dépend en grande partie du nombre d'écrans et de l'emplacement de ces derniers. Le type de lettres utilisées, la taille et la couleur de celles-ci (p. ex., lettres jaunes ou blanches sur un fond bleu ou noir), l'utilisation d'une surface anti-reflet et le temps d'affichage des messages sont autant de facteurs qui contribuent à l'efficacité des systèmes d'affichage.
- De l'avis des participants au projet, le curseur clignotant sur le tableau d'affichage était dérangeant et agaçant. La dernière ligne du tableau d'affichage, réservée pour les messages additionnels, est trop basse et peut être cachée par les voyageurs ou les employés qui se tiennent debout.
- Le temps d'affichage des messages devrait être accru.
- Dès le départ, on devrait informer les participants de l'existence et de l'emplacement des systèmes d'affichage textuels dans l'aéroport et aux portes d'embarquement.
- Les messages affichés devraient transmettre des informations complètes et détaillées afin d'éviter toute ambiguïté. Le message «vol annulé» ne précise pas ce que les voyageurs doivent faire.
- Il était difficile de comprendre les messages diffusés sur le système de sonorisation. La clarté des messages ainsi diffusés peut dépendre de la voix de l'annonceur, du débit du message, du bruit ambiant, de la qualité des systèmes et de l'acoustique de l'aéroport.

En ce qui concerne l'aspect technique, il serait possible d'utiliser les tableaux d'affichage électroniques installés aux portes d'embarquement pour afficher des informations textuelles et ce, sans qu'aucune modification ne soit nécessaire. Il

pourrait même être possible d'afficher des messages textuels en français et en anglais. Il suffirait de diffuser les messages sur la dernière ligne du tableau et d'alterner entre les deux langues. Actuellement, les écrans d'affichage en temps-réel installés aux portes d'embarquement et dans l'aérogare ne sont pas exploités, mais la technologie et les périphériques d'entrée existent. Pour mettre au point un système d'affichage aux portes d'embarquement, il faudrait installer des écrans, du matériel et des logiciels. Pour faire la même chose à l'échelle de l'aérogare, le système doit pouvoir être accessible aux divers intervenants qui participent aux activités aéroportuaires (c.-à-d., les transporteurs aériens, les autorités aéroportuaires, les membres du service de sécurité, les responsables de l'information, etc.). L'affichage de messages sur les écrans d'information sur les vols est impossible pour l'instant puisque l'usage de ce système est restreint dans les aéroports.

Actuellement, l'utilisation des tableaux d'affichage électroniques se fait par le biais des agents d'embarquement et nécessiterait de 15 à 20 secondes additionnelles de leur temps pour la saisie des messages. Il en irait de même pour la saisie des messages diffusés sur les différents écrans de l'aérogare.

En s'appuyant sur les conclusions de l'étude, on propose les recommandations suivantes :

- Utiliser la dernière ligne du tableau d'affichage électronique pour diffuser des messages textuels en plus des messages sonores, ce qui contribuerait à améliorer les informations d'embarquement pour de nombreux voyageurs, particulièrement ceux qui sont atteints de déficiences auditives et cognitives. Utiliser les écrans pour afficher des messages textuels lorsqu'il n'y a pas de tableau d'affichage électronique.
- Ajouter le symbole de déficience auditive aux messages diffusés sur l'afficheur et déterminer la taille, la couleur et le type de caractères en se basant sur les normes internationales et les principes ergonomiques.
- Déterminer le nombre et l'emplacement des afficheurs dans les aires d'attente de l'aérogare. Placer ces afficheurs dans des endroits libres de toute autre information visuelle.
- Réduire la taille du curseur sur le tableau d'affichage électronique et en éliminer le clignotement. Surélever le tableau d'affichage de sorte que la dernière ligne de ce dernier se trouve au-dessus de la tête de 95 p. 100 des hommes se tenant debout. La dernière ligne doit être lisible de n'importe quel point de lecture potentiel à l'intérieur de l'aire d'attente.

- Déterminer la durée d'affichage des messages. Une durée minimale d'affichage doit être déterminée pour les messages affichés dans l'aérogare, particulièrement lorsque différents intervenants souhaitent afficher simultanément un message (c.-à-d., les transporteurs aériens, les autorités aéroportuaires, les membres de la sécurité, les responsables de l'information, etc.).
- Sensibiliser les voyageurs aux systèmes d'affichage de messages textuels (transporteurs aériens, autorités aéroportuaires, associations représentant les personnes atteintes de déficiences auditives et cognitives et médias pertinents).
- Éviter les messages ambigus en affichant des messages clairs et précis (p. ex., vol annulé, se reporter à l'agent).
- Améliorer la qualité sonore du système de sonorisation et la vitesse à laquelle sont diffusés les messages dans l'aérogare et aux portes d'embarquement. Améliorer l'acoustique des aérogares et réduire le bruit ambiant.
- Élaborer un programme interne de démonstration en collaboration avec les transporteurs aériens afin de surveiller et d'évaluer le rendement des afficheurs installés aux portes d'embarquement, lorsque des afficheurs sont disponibles, et utiliser un affichage plein écran.

Table of Contents

1 INTRODUCTION 1

1.1 Background 1

1.2 Purpose 2

1.3 Scope 2

2 IDENTIFICATION OF TEXT DISPLAY TECHNOLOGIES 5

2.1 Responses from Associations 5

2.2 Text Display Technologies 5

2.2.1 LED (Light Emitting Diode) displays with dot matrix characters 7

2.2.2 Segmented character type 7

2.2.3 LCD (Liquid Crystal Displays) 7

2.2.4 Digital displays 7

2.2.5 Text on monitors (line captioning, full screen) 7

3 IDENTIFICATION OF TARGET GROUP AND DISABILITY CHARACTERISTICS 9

3.1 Persons Who Are Deaf or Hard of Hearing 9

3.1.1 Functional limitations associated with hearing disabilities 9

3.1.2 Transportation difficulties 9

3.2 Persons Who Are Cognitively Impaired 10

3.2.1 Functional limitations 10

3.2.2 Transportation difficulties 11

4 METHODOLOGY 13

4.1 Display Design for Gate 13

4.1.1 Reader board 13

4.1.2 Text monitor 14

4.2 Display Technologies within the Terminal 14

4.2.1 FID monitor 14

4.2.2 Visual paging monitor 15

4.3 Text Display Production for Demonstration 16

4.3.1 Full screen monitor at gate 16
4.3.2 FID monitor in terminal 17
4.3.3 Visual paging monitor in terminal 17
4.4 Purpose of the Evaluation 18
4.5 Test Methodology and Data Collection Tools 18
4.5.1 Checklist assessment of ergonomics 19
4.5.2 Questionnaires 19
4.5.3 Observational recording sheet 20
4.5.4 Questionnaires for technical and operational issues 20
4.5.5 Photographic record 20
4.6 Trial Plan 21
4.6.1 Research design 21
4.6.2 Conditions and participants 21
4.6.3 Participant groups 21
5 APPROACH 23
5.1 Trial Conditions 23
5.1.1 No technology condition at the gate 23
5.1.2 Reader board condition at the gate 23
5.1.3 Monitor condition at the gate 23
5.1.4 No technology condition in the terminal 23
5.1.5 Captioned flight information display monitor 23
5.1.6 Full screen text display 24
5.2 Test Locations 24
5.2.1 Technologies at the gate counter 24
5.2.2 Technologies in the terminal area 24
5.3 Scenarios 24
5.3.1 Scenarios at the gate 25
5.3.2 Scenarios in the terminal (non-secure area) 28
6. DATA COLLECTION 32

6.1 Gate Scenarios 33
6.2 Terminal Scenarios 37
7 Results 41
7.1 Demographics 41
7.1.1 Use of the Ottawa airport terminal 41
7.1.2 Pre-test perception of helpfulness of visual message displays 42
7.1.3 Difficulties encountered in the Ottawa airport terminal 43
7.2 Human Factors of Visual Messaging Systems 45
7.2.1 Level of difficulty for all technology conditions 45
7.2.2 Completion of task 46
7.2.3 Level of helpfulness and readability of each technology 49
7.3 Discussion of Human Factors Results 51
7.4 Technical Feasibility 51
7.4.1 Electronic reader board at gates 51
7.4.2 Visual information monitors at gates 52
7.4.3 Captioning on FID monitors 52
7.4.4 Visual paging 52
7.5 Operational Feasibility 53
7.5.1 Electronic reader board at gates 53
7.5.2 Visual information monitors at gates 53
7.5.3 Captioning on FID monitors 53
7.5.4 Visual paging 54
7.6 Cost Estimates 54
7.6.1 Electronic board systems 54
7.6.2 Visual information monitors at gates 54
7.6.3 Visual paging unit 54
8. CONCLUSIONS 55
8.1 Human Factors and Technologies 55
8.2 Technical 56

8.3 Operation 56
9 RECOMMENDATIONS 57
References 59
Appendix A: Observation Sheet
Appendix B: Pre-test Questionnaire
Appendix C: Post-test Questionnaires
Appendix D: Ergonomic Checklist
Appendix E: Technology Survey

List of Figures

Figure 1: Responses from the disabilities associations....6
Figure 2: Message to be shown on lower line of reader board....13
Figure 3: Message to be shown on monitor screen....14
Figure 4: Example of a FID monitor screen design....15
Figure 5: Visual paging screen....16
Figure 6: International broken ear symbol....17
Figure 7: Research design....22
Figure 8: Layout of waiting lounge at gate 16, Air Canada, Ottawa International Airport (not to scale); dimensions in metres....33
Figure 9: Test set-up at gate 16, Ottawa airport....34
Figure 10: Non-technology demonstration....34
Figure 11: Electronic board display, data input by gate agent via laptop....35
Figure 12: Visual info monitor mock-up with text display of audio message spoken by gate agent....35
Figure 13: Close-up of text message shown on visual info monitor. Monitor panel showing international symbol for persons who are hearing impaired or deaf....36
Figure 14: Layout in terminal at international arrivals waiting lounge (not to scale)....37
Figure 15: Non-technology, info booth agent making audio announcement over general PA system....38
Figure 16: Test set-up for FID monitor mock-up at waiting lounge, international arrivals, Ottawa International Airport....38
Figure 17: Close-up of departure monitor mock-up. Monitor panel shows international symbol for persons who are hearing impaired....39
Figure 18: Test subject reading text display on last two lines of FID monitor....39
Figure 19: Test set-up for visual paging monitor at international arrivals....40
Figure 20: Mock-up of text display on visual paging monitor with the international symbol for persons who are hearing impaired or deaf....40
Figure 21: Use of Ottawa International Airport per year....42

Figure 22: Experience with all methods 46
Figure 23: Summary of messaging helpfulness 50
Figure 24: Level of readability for each technology 50

List of Tables

Table 1: Messages at gate – No technology 26
Table 2: Messages at gate – Electronic reader board 27
Table 3: Messages at gate – Monitor 28
Table 4: Messages in terminal – No technology 29
Table 5: Messages in terminal – Display on FID monitor 30
Table 6: Messages in terminal – Display on full screen monitor 31
Table 7: Distribution of participants 41
Table 8: Pre-test perceived helpfulness of visual displays 42
Table 9: Summary of participants' comments of communication difficulties 44
Table 10: Successful completion of the task 47
Table 11: Summary of participants' comments on each technology 48

1 INTRODUCTION

"The airline agent at the gate snatches her boarding pass and tells her, most indignantly, that she should have been there a half-an-hour ago as the announcement instructed. The passenger does not respond, but only smiles. She has heard nothing. She is deaf!" [1]

Several studies in Canada have addressed the incidence of disabilities amongst the Canadian population. Based on the Health and Activity Limitation Survey (HALS) report of 1991 by Statistics Canada and the TransAccess database of 1995 by Goss Gilroy Inc, an estimated 3.8 million adults in households have a disability. In 1995 this accounted for 17.1% of the 22.2 million adults residing in Canada, representing 3,813,000 persons with disabilities. In 1995 it was estimated that of the 2.9 million with transportation disabilities, 715,000 travel by air. Of these, 31.7% have hearing problems and 23.7% have other problems (not including mobility, agility, seeing, or speaking). Persons over the age of 65 are expected to increase from 3.2 million in 1995 to 7.8 million in 2025, many of them potential candidates for hearing and cognitive problems.

1.1 Background

In transportation terminals, travellers who are deaf or those with severe hearing impairments may not receive public audio messages. Travellers with cognitive impairments and many elderly persons may not receive an audio message clearly enough to react. When hearing or comprehension is impaired, there is an increased dependence on other sensory information, particularly visual information. Both groups need an alternative message in visual format. Not reaching this group who cannot hear the audio message could result in severe consequences for the person's safety, leaving a person stranded or missing some important flight information.

Messages in terminals can include:

- Paging a person;
- Final boarding call;
- Evacuation instructions; and
- Emergency and evacuation instructions.

Messages at gate counters can include:

- Boarding instructions (pre-boarding, boarding by row);

- Gate change;
- Paging a person for standby/ticketing, etc.;
- Flight information (delays, change of aircraft, change of gate); and
- Emergency and evacuation instructions.

The need to improve accessibility in transportation terminals for sensory impaired travellers has been a concern of Transport Canada's Transportation Development Centre (TDC) for many years. Several studies laid down the groundwork to address the federal government's mandate to make travel accessible for all persons, including those with sensory and cognitive impairments. Their needs were identified in the following studies:

1. *Evaluating the User-Interface of Information and Communication Systems for Travellers with Sensory and Cognitive Disabilities On-Board Transportation Vehicles* [2]
2. *Improving Transportation Information: Design Guidelines for Making Travel More Accessible* [3]
3. *Communication Barriers - A Look at Barriers to Communication Facing Persons with Disabilities Who Travel by Air* [4]
4. *Assessment of In-Cabin Information Technologies for Passengers with Sensory and Cognitive Impairments* [5]
5. *Demonstration and Evaluation of Wayfinding Technologies for Travellers with Sensory Disabilities at Edmonton International Air* [6]

In [6] several technologies were identified with great potential to improve information and communication in air terminals for sensory impaired travellers. Among the most recommended technologies by subjects with hearing and cognitive impairments was an electronic reader board at gate counters and open captions on terminal monitors.

1.2 Purpose

The purpose of this project was to demonstrate and evaluate visual messaging systems to determine the most effective technology for communicating messages to persons with hearing or cognitive disabilities in airport terminals.

1.3 Scope

Subjects for the study included persons who are deaf, those who are hard of hearing and those with cognitive impairments. The study focused on the

demonstration and evaluation of selected technologies at Ottawa International Airport with the co-operation of Air Canada and the airport authority.

2 IDENTIFICATION OF TEXT DISPLAY TECHNOLOGIES

In previous projects carried out for the Transportation Development Centre, it was indicated that in public transportation terminals persons with hearing and cognitive disabilities had the most difficulty receiving or comprehending audio public announcements as well as boarding instructions at the gates. In most cases a visual display was recommended as an alternative. To verify these recommendations, the project team contacted three associations representing persons who are deaf, persons who are hard of hearing and persons with learning disabilities to identify most appropriate alternatives to audio PA systems in an airport environment. The associations included the Canadian Association of the Deaf, the Canadian Hard of Hearing Association, and the Learning Disability Association of Canada. The feedback from all three associations clearly indicated that the technological alternatives include:

- Full screen text display on monitors;
- Text display on electronic reader boards;
- Captioning on monitors.

2.1 Responses from Associations

Figure 1 shows the responses received from each of the associations polled regarding preferences for each technology.

2.2 Text Display Technologies

There are several text display technologies available. They include:

- Light Emitting Diode (LED) Displays
- Liquid Crystal Displays (LCD)
- Dot matrix displays
- Text on monitor
- Open captioning on video monitor
- Closed captioning on monitor
- Printed text
- Projected text

TECHNOLOGY Alternatives (not prioritized)	CAD Canadian Association of the Deaf	CHHA Canadian Hard of Hearing Association	LDAC Learning Disability Association of Canada	Applic-able to all groups
Text display on a monitor	X	X	X	X
Electronic reader board	X	X	X	X
Captioning on lower part of a monitor			X	
Printed matter			X	
Face to face			X	
Paper and pencil				
Travel companion	X		X	
Infrared or frequency modulated radio system		X		

Figure 1: Responses from the disabilities associations

Of the above technologies, only the first five (LED, LCD, dot matrix, text on monitor, and open captioning on monitor) qualify for use in an airport environment. Closed captioning requires a special receiving device for the user, printed text is not feasible to address a large number of passengers in a waiting lounge or to single out specific passengers, and projected text requires a complex equipment set-up.

A review of visual display technologies was carried out using the following sources:

- Literature review (TDC, Oregon university, in-house library);
- Technologies currently used in airports in Ottawa, Toronto, Dorval, and Vancouver;
- Internet (manufacturers and suppliers).

To provide changeable text display, the following technologies were selected and their characteristics are described in subsections 2.2.1 through 2.2.5.

2.2.1 LED (Light Emitting Diode) displays with dot matrix characters

5x7 matrix:	minimally acceptable
7x9 matrix:	preferred for general applications
8x11 matrix:	minimum if symbols rotated
15x21 matrix:	preferred if symbols rotated

2.2.2 Segmented character type

7 segments:	numerical information only
14 segments:	preferred for general application

2.2.3 LCD (Liquid Crystal Displays)

- All LCDs are limited in their character generation and colour capabilities and are generally more expensive than LEDs.
- Reflecting LCDs are not as legible as dot matrix or LED displays, and perform poorly in low light.
- Transmissive LCDs that are back-lighted are very clear in low lighting conditions.
- Transreflective LCDs are suitable for both high and low illumination levels.

2.2.4 Digital displays

Any character type, size, colour and background can be displayed in digital format.

2.2.5 Text on monitors (line captioning, full screen)

Text can be displayed in any size, type, colour and on any coloured background. For the purpose of displaying variable messages in an airport environment the technologies must comply with the following criteria:

- Legibility for distances up to 10 m for passengers seated and standing in waiting lounges
- Clear line of sight to text display for seated and standing passengers
- Changeability of text in real time
- Message input in real time by agent(s), gate specific
- Message input in terminal's public areas, for general purpose

3 IDENTIFICATION OF TARGET GROUP AND DISABILITY CHARACTERISTICS

3.1 Persons Who Are Deaf or Hard of Hearing

In its guidelines for the design of consumer products for persons with hearing disabilities, the Trace R&D Center wrote:

> *"Hearing impairment means any degree and type of auditory disorder, while deafness means an extreme inability to discriminate conversational speech through the ear. People who are deaf are those who cannot use their hearing for communication. People with a lesser degree of hearing impairment are called hard of hearing."* [7]

While hearing loss can be found in all age groups, the loss of hearing acuity is part of the natural ageing process. With a larger population of elderly predicted for the future, the number of persons with a hearing disability will certainly increase.

3.1.1 Functional limitations associated with hearing disabilities

Functional limitations that can be experienced by people who are deaf or hard of hearing can include:

- reduced ability to hear high and/or low frequency tones (for example, a child can hear a sound frequency of 20,000 Hz; at age 30, a person can hear up to 15,000 Hz; at age 50, the limit is 13,000 Hz),
- Reduced ability to differentiate between tones, and
- Reduced ability to block out environmental noise.

3.1.2 Transportation difficulties

The following translates the functional difficulties into difficulties that may be experienced from a transportation perspective, in particular for the airport environment.

- Hearing public announcements (e.g. paging, schedule delays, emergencies);
- Communicating with terminal personnel, including ticket staff and security staff;
- Hearing boarding announcements at gate counters (e.g. pre-boarding, boarding by rows, gate changes, stand-by paging, cancellations, emergencies).

3.2 Persons Who Are Cognitively Impaired

The type of cognitive disabilities can vary widely. They are often invisible and have no distinctive characteristics or appearances. Cognitive disabilities can range from mild and moderate, to severe difficulties with perception, memory, comprehension, and/or learning, or to severe mental illness or retardation and dementia.

Cognitive disabilities can be categorized as:

- Learning related (including difficulties with problem identification, problem solving, evaluation of alternatives and outcomes, and difficulties with respect to comprehension and skill development),
- Memory related (including short- and long-term memory, and ability to recognize and recall previously experienced situations),
- Perception related (including ability to absorb and perceive sensory-related information),
- Conceptualizing disabilities (which can include problems in sequencing, generalizing previously learned information, categorizing, cause and effect, and understanding abstract concepts), and
- Mental retardation (defined as individuals with an IQ of less than 70).

3.2.1 Functional limitations

Due to the wide range of cognitive disabilities, the types of functional limitations that can result also vary widely. Generally they can result in:

- Slower retrieval and processing of information,
- Diminished spatial orientation and visual-motor integration,
- Diminished learning rates,
- Reduction in ability to divide attention between two or more tasks,
- Reduction in searching and scanning abilities which require selective attention,
- Problems perceiving and/or discriminating particular situations or variables, and
- Increased difficulty ignoring irrelevant stimuli.

3.2.2 Transportation difficulties

The following translates the functional difficulties into difficulties that may be experienced from a transportation perspective, in particular for the airport environment.

- Understanding public announcements,
- Understanding boarding announcements at the gate,
- Communicating with carrier, terminal and security personnel,
- Interpreting displays and signage,
- Interpreting schedule information, including arrival/departure status and changes,
- Orientation and way finding, and
- Locating public amenities.

4 METHODOLOGY

The methodology for the technology set-up and the human factors evaluation are described in this section.

4.1 Display Design for Gate

The following displays are the design concepts used for the gate area. They include the electronic reader board and the text monitor.

4.1.1 Reader board

The research team used the reader board that exists at the gates in the secure areas of the Ottawa terminal.

***Example of a reader board design (Figure 2)*:**

Agent PA: "**Air Canada announcing flight 1020 to Tokyo. We are pre-boarding now. Anybody who needs assistance please proceed to the gate.**"

Figure 2: Message to be shown on lower line of reader board

4.1.2 Text monitor

A mock-up of a full screen monitor was placed on a stand and positioned near the gate counter at a height of about 2.03 m (equipment supplied and text display produced by research team).

Example of the full-text monitor mock-up design (Figure 3):

Agent PA: **"This is Air Canada flight 1020 to Tokyo. We are pre-boarding now. Anybody who needs assistance please proceed to the gate."**

Figure 3: Message to be shown on monitor screen

4.2 Display Technologies within the Terminal

The following technologies were designed to be used in the terminal area.

4.2.1 FID monitor

A mock-up FID monitor with open captioning was placed on a stand (equipment supplied and text display produced by research team) and designed as shown in Figure 4.

ARRIVALS
FLIGHT ORIGIN TIME STATUS
AC 407 TORONTO 11:00 ON TIME
BS 301 HAMILTON 11:20 ON TIME
USAIR CHICAGO 12:30 ARR
AC 612 MONTREAL 12:45 ARR
PASSENGER A. SMITH PLEASE REPORT TO INFO BOOTH AT ARRIVAL LEVEL

Figure 4: Example of a FID monitor screen design

The information agent would announce the following message on the PA:

"Would passenger A. Smith please report to the information booth at the arrival level?"

This same message would be entered using an additional function of the FID display software.

4.2.2 Visual paging monitor

A full-screen paging monitor on a stand with display at 1.30 m high (equipment supplied and text display produced by research team) was mocked up as shown in Figure 5.

Example of a full screen visual paging monitor (Figure 5)

A message from PA announcer: **"Would passenger A. Smith please report to the information booth at the arrival level?"** is also entered into the proposed paging monitor's display software.

Figure 5: Visual paging screen

4.3 Text Display Production for Demonstration

Text displays were produced for the following scenarios:

1. Full screen monitor at the gate
2. FID monitor in terminal
3. Visual paging monitor in terminal

All messages were shown in English but would alternate between English and French when in actual service.

4.3.1 Full screen monitor at gate

A 20 in. colour monitor with a VCR was placed on a movable stand at a height of 1.80 m with a large sign placed on top of the monitor facing the front. The sign had a black background with white letters displaying the words " Visual info" with the international sign of the "broken ear" for people who are hard of hearing or deaf. Letters were 5 cm high in Arial font.

For the monitor at the gate, screens were designed and produced as mock-ups for display. The screen would show the text "Flight Announcements" only to indicate the place for visual announcements. The screen would show text messages when the gate agent made PA announcements.

Message display design

The monitor screen background was in black with white letters, type Arial, with capital and lower case letters. A double spacing separated the "Flight

Announcements" top line from the actual message. All text lines were centred horizontally on the screen. The line "Flight Announcements" would slowly fade in and out several times to attract attention to the screen combined with a "ding-dong" audio signal with each fading. Fading combined with the audio signal would be at approximately 15-second intervals. The actual text message would not fade or move.

4.3.2 FID monitor in terminal

For general announcements in the terminal's public areas, a departure screen was designed that looked similar to the one used in the airport but with fictional information. As on the actual departure and arrival monitors, there were two lower lines on the monitor that were not used. In the mock-up the lower two lines of the monitor were used to display text messages similar to those spoken over the general PA system.

Message display design

The monitor screen was designed so that each flight appeared in a different horizontal colour background band with black lettering in upper case, type Arial. Upper case was used to draw attention to the monitor. Readability of the message did not seem to be affected by the choice of upper case. For the last two lower lines the background was black with white letters displaying the respective audio message. At the moment of text display, an audio signal "ding-dong" would sound several times at 15 second intervals.

4.3.3 Visual paging monitor in terminal

As an alternative to text displays on FID monitors where only the last two lines of the monitor can be used, a visual paging monitor was mocked up and placed on a movable stand about 1.80 m above the ground. A horizontal black panel was placed on top of the monitor with the international "broken ear" sign (see Figure 6) 15 cm high, together with the words "Visual Paging" in 4 cm high white lettering. Messages were recorded on a VHS tape and played via a VCR.

Figure 6: International broken ear symbol

Message display design

Messages were displayed on the monitor for two situations: (i) when no announcements are made, only the text "Visual Paging" appears on the top of the screen in large letters, and (ii) when a text message is displayed it is shown with a double spacing following the top line. When the message appears, the top line " Visual Paging" fades in and out with the text message not moving. Combined with the fading sounds a "ding-dong" audio signal to attract attention.

4.4 Purpose of the Evaluation

The purpose of the human factors evaluation portion of the demonstration was to assess the usability of visual display technologies during airport terminal scenarios. The demonstration examined the impact of these technologies on user performance, and identified potential problems with both the design of the technologies and their implementation within the airport terminal environment. The specific goals of the work were to:

- Assess the technologies for compliance with ergonomic standards;
- Test the technologies for usability within a real life setting; and
- Conduct the test using six situations – (i) no assistive technology at the gate, (ii) reader boards at the gate, (iii) text monitor at the gate, (iv) no technology in the terminal, (v) captioning on the flight information display (FID) in the terminal, and (vi) full text monitors in the terminal.

4.5 Test Methodology and Data Collection Tools

The test methodology was developed according to well-established methods used for the evaluation of the usability of equipment and its impact on user performance. This methodology was used successfully at the Edmonton airport to assess several wayfinding technologies [6]. The methodology includes:

- Checklist assessment of compliance with ergonomics standards (Appendix D);
- Survey questionnaires used to collect specific information on the usefulness and effectiveness of the technologies studied, following each trial (Appendices B and C);

- Observational recording sheet used to capture real-time data on the performance of information seeking tasks, errors made, and other difficulties experienced by the participants (Appendix A);
- Specific environmental conditions noted (specific distractions, traffic volumes, lighting, glare, noise, etc.);
- Photographic and video footage taken to verify or illustrate specific problems and areas where difficulties arose.

4.5.1 Checklist assessment of ergonomics

The technologies were assessed for their conformance to basic ergonomic standards using a checklist (see Appendix D). The checklist included:

- Specific physical dimensions such as screen size and shape, angles of view, maximum viewing distance, minimum character height and width, and stroke width;
- Visual characteristics of text such as illumination, contrast, reflectance, use of colour, flicker, and internal glare sources;
- Functional characteristics such as display time for messages, movement of text, flashing, and placement of groups of information; and
- Environmental characteristics such as ambient noise, external glare sources, and disruptions to lines of sight.

4.5.2 Questionnaires

The participants were asked to complete a written questionnaire on completion of each of their trials. The questionnaire addressed the following areas:

- What information they obtained;
- Whether this information was adequate to satisfy their goal;
- How they felt not being able to achieve their goal;
- What information was missing;
- What difficulties they encountered;
- What problem they perceived caused any difficulties;
- What they think would have improved the present situation;
- What other information would have been helpful;

- How this information should be conveyed.

4.5.3 Observational recording sheet

The participants were observed during their trials. These observations noted:

- Level of activity in the area;
- Environmental characteristics;
- The participants' behaviour, focussing on their outward level of comfort and whether their attention is directed to other stimuli;
- The participants' performance including;
  - How long it takes for them to notice the message;
  - Whether they actually hear or see the message;
  - Noticeable possible misunderstanding of the message;
  - Whether they act appropriately in response to the message;
  - Whether they completed their goal.

4.5.4 Questionnaires for technical and operational issues

Airport authorities and carriers were interviewed. Issues included:

- Use of present reader boards by agents, time constraints;
- Equipment ownership;
- Pre-recording of text messages;
- Use of both official languages;
- Feasibility of monitor display;
- Use of FID monitors for open captioning;
- Gate agents' responsibilities and duties for announcements;
- Use of PA system in terminals by several parties.

4.5.5 Photographic record

Photographs were taken of some trials to illustrate the method and set-up, point out specific problems, record sequences for presentation purposes and support the analysis.

4.6 Trial Plan

4.6.1 Research design

The research design is shown in Figure 7. The approach involved observing the participants while they used the technology during a scenario. The participants were asked to pretend that they were passengers or waiting for passengers, depending on the scenario.

4.6.2 Conditions and participants

Conditions

The six conditions for the trials were:

1. No technology at gate;
2. Reader board at gate;
3. Text monitor at gate;
4. No technology in the terminal;
5. Captioned FID monitor in terminal;
6. Visual paging monitor in terminal.

4.6.3 Participant groups

Three participants represented each of the following three groups:

1. Individuals who are hard-of-hearing;
2. Individuals who are deaf; and
3. Individuals who have cognitive disabilities.

Each participant completed six trials.

All of the technology conditions were available; however, the reader board was available only when the airline was not using the gate. Hence, the trials had to be run as groups. That is, each representative group participated on a particular day and completed the trials together. This did not allow a random arrangement of technology for each group, but did provide a more natural scenario.

		At the Gate			In the Terminal		
	PARTICIPANT	**No Tech.**	**Reader Board**	**Monitor**	**No Tech.**	**FID/ Caption**	**Full Screen**
DAY 1 Feb.26, 2002	Hard of Hearing (3)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
DAY 2 Feb.27, 2002	Cognitively Disabled (3)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
DAY 3 Feb.28, 2002	Profoundly Deaf (3)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6

Figure 7: Research design

5 APPROACH

5.1 Trial Conditions

The approach required that the following six conditions be set up for all three days of testing.

5.1.1 No technology condition at the gate

The No Technology condition mimicked the existing procedures used by airlines for communicating with passengers who have disabilities. An agent assisted by making announcements, created by the research team, over the PA system. Standard procedure was followed, including the extra assistance normally provided to those with complete loss of hearing.

5.1.2 Reader board condition at the gate

Dot matrix reader boards, as described in section 4, were used to convey announcement information to passengers.

5.1.3 Monitor condition at the gate

The research team configured a standard cathode ray tube (CRT) monitor to mimic the standard flight information and contain two lines at the bottom of the screen for captioning. The captioned lines used to display messages created by the research team were difficult to read.

5.1.4 No technology condition in the terminal

Information pertaining to specific passengers was provided by the conventional means currently used by the airlines.

5.1.5 Captioned flight information display monitor

A CRT monitor was prepared to mimic the flight information seen on the airport terminal's standard FID with an additional two lines at the bottom of the screen for announcements in English and French. The monitor was elevated on a stand at the optimum height for viewing by all passengers within a distance appropriate for the viewing area.

5.1.6 Full screen text display

A CRT monitor was set up as a full text display. Text messages were displayed representing announcements that are typical of information provided by airlines for their passengers.

5.2 Test Locations

The demonstration took place in the following test locations at Ottawa International Airport terminal:

- At Air Canada gate counters 16 and 18 on departure level;
- At the international arrival area within the terminal (non-secure) where FID monitors are used.

5.2.1 Technologies at the gate counter

The following technologies were used at the gate area:

- Electronic reader boards (using Air Canada's system);
- Full screen monitor on a stand, positioned near the gate counter, at about 2.03 m high.

5.2.2 Technologies in the terminal area

The following technologies were used in the terminal area:

- Full screen monitor on a stand, positioned near the gate counter, at about 2.03 m high;
- Mocked-up FID monitor with message at the lower part of the screen.

5.3 Scenarios

The trials were conducted using the following scenarios. Certain scenarios were slightly different for those who are deaf, as indicated.

5.3.1 Scenarios at the gate

Scenario 1 – No Technology at the Gate

This scenario unfolded as follows:

- Participants were asked to sit down in the gate lounge area, near the gate counter;
- Participants waited in the lounge area as they normally would when taking a flight;
- An Air Canada agent announced typical boarding messages at three specific times (Table 1), e.g. " *we are pre-boarding now*", "*we are now boarding rows 25 -38*", etc.

A group of three subjects (each representative group participating on their designated day – see Figure 7) was introduced to the project at hand and its objective, but not to the technologies. The scenario was briefly described and all participants proceeded to a neutral holding area from where they could not observe the demonstrations.

The groups that were hard of hearing or cognitively impaired were tested with the currently non-alternative technology procedure used by Air Canada. Each participant was asked, via questionnaire, which of the PA messages they heard or understood.

Table 1: Messages at gate – No technology

PA announcements by gate agent in English and French	Visual Display: None
We are now pre-boarding flight 1020 to Tokyo. Passengers who require assistance, please proceed to gate 16.	None
We are boarding flight 1020 to Tokyo in sequence. Passengers seated in rows 12 to 25 can board now.	None
Passengers seated in rows 26 to 35 can board now.	None
May I have your attention please. Flight 1020 to Tokyo is cancelled due to a snowstorm. Would passengers please come to the Air Canada counter.	None
Would passenger A. Smith please report to the Air Canada counter at gate 16.	None

Scenario 2 - Electronic Reader Board at Gate Counter

Each group of participants was brought to the gate waiting area and seated to wait for boarding. The Air Canada gate agent verbally delivered boarding messages over the PA system and displayed the same content in text format on the electronic board as shown in Table 2. The participants were told of the circumstances when and how these text messages would appear. Each participant was asked which visual messages he/she saw and how easy these messages were to read and understand.

Table 2: Messages at gate – Electronic reader board

PA announcements by gate agent in English and French	Visual Display: On last line in English
We are now pre-boarding flight 1020 to Tokyo. Passengers who require assistance, please proceed to gate 16.	PRE-BOARDING NOW
We are boarding flight 1020 to Tokyo in sequence. Passengers seated in rows 12 to 5 can board now.	BOARDING ROWS 12-25 NOW
Passengers seated in rows 26 to 35 can board now.	BOARDING ROWS 26-35 NOW
May I have your attention please. Flight 1020 to Tokyo is cancelled due to a snowstorm. Would passengers please come to the Air Canada counter?	FLIGHT 1020 IS CANCELLED
Would passenger A. Smith please report to the Air Canada counter at gate 16?	A.SMITH PLEASE TO COUNTER

Scenario 3 - Full Screen Monitor at Gate Counter

Each group was brought to the waiting area at the gate. The gate agent verbally delivered boarding messages over the gate's PA system. At the same time, a text message with the same content was displayed on the monitor's full screen. The participants were told of the circumstances when and how these text messages would appear (Table 3). Each participant was asked which visual messages he/she saw and how easy the messages were to read and understand.

Table 3: Messages at gate – Monitor

PA announcements by gate agent in English and French	Visual Display: Full screen monitor in English
We are now pre-boarding flight 1020 to Tokyo. Passengers who require assistance, please proceed to gate 16.	FLIGHT ANNOUNCEMENT WE ARE PRE-BOARDING FLIGHT 1020 NOW
We are boarding flight 1020 to Tokyo in sequence. Passengers seated in rows 12 to 25 can board now.	FLIGHT ANNOUNCEMENT WE ARE BOARDING ROWS 12-25 NOW
Passengers seated in rows 26 to 35 can board now.	FLIGHT ANNOUNCEMENT WE ARE BOARDING ROWS 26-35 NOW
May I have your attention please. Flight 1020 to Tokyo is cancelled due to a snowstorm. Would passengers please come to the Air Canada counter.	FLIGHT ANNOUNCEMENT FLIGHT 1020 TO TOKYO IS CANCELLED. PLEASE REPORT TO COUNTER
Would passenger A. Smith please report to the Air Canada counter at gate 16.	FLIGHT ANNOUNCEMENT WOULD PASSENGER A.SMITH PLEASE COME TO THE COUNTER

5.3.2 Scenarios in the terminal (non-secure area)

Scenario 4 - No Technology in the Terminal

Each group was exposed to several mocked-up messages (Table 4) provided over the general PA system and their responses recorded as to which of the messages they heard and what content they remembered. The participants were told of the

circumstances when and how these text messages would appear. Participants of the hard of hearing and the cognitively impaired group participated, but none of the group of subjects who are deaf participated this trial. The researchers recorded the results on the observation sheets.

Table 4: Messages in terminal – No technology

PA announcements by info booth agent in English and French	Visual Display: None
Would passenger A. Smith please report to the information counter at the arrival level.	None
Would the owner of a white Honda, licence plate XYZ-123 please come to the information counter.	None
Car keys have been found. Please come to the Air Canada counter.	None
Would B. Young please come to international arrivals.	None
This is the last boarding call for flight 1020 to Tokyo.	None

Scenario 5 - FID with Open Captions in the Terminal

A stand with a monitor and a VCR was mocked up and displayed a FID announcement (produced by the research team) similar to the departure and arrival monitors but with a two line open captioning at the bottom of the screen. The participants were told of the circumstances when and how these text messages would appear. From a neutral holding area each group was exposed to the messages on the screen and asked about the message content via questionnaires.

Table 5: Messages in terminal – Display on FID monitor

PA announcements by info booth agent in English and French	Visual Display: on FID monitor in English
Would passenger A. Smith please report to the information counter at the arrival level.	Passenger A. Smith please report to info counter at arrivals.
Would the owner of a white Honda, licence plate XYZ-123 please come to the information counter.	Owner of white Honda XYZ-123 please come to info counter.
Car keys have been found. Please come to the Air Canada counter.	Car keys have been found. Please come to the Air Canada counter.
Would B. Young please come to international arrivals.	B. Young please come to international arrivals.
This is the last boarding call for flight 1020 to Tokyo.	This is the last boarding call for flight 1020 to Tokyo.

Scenario 6 - Text on Full Screen in the Terminal

Each group was exposed to text messages on the screen. These messages (Table 6) included: paging a passenger, reporting to the carrier's counter, reporting to the info counter, etc. The participants were told of the circumstances when and how these text messages would appear. The researchers recorded the results on the observation sheets.

Table 6: Messages in terminal – Display on full screen monitor

PA announcements by info booth agent in English and French	Visual Display: Full screen visual paging monitor in English
Would passenger A. Smith please report to the information counter at the arrival level.	**Visual Paging** A. Smith please come to info booth at arrivals
Would D. Brown please come to the Air Ontario counter.	**Visual Paging** D. Brown please come to Air Ontario counter
Would the owner of a red Ford with licence plate ZVK-321 please report to the RCMP.	**Visual Paging** Owner of red Ford ZVK-321 please report to RCMP
A wallet has been found. Please come to the Air Alliance booth.	**Visual Paging** Wallet has been found. Please come to Air Alliance counter.
Would E. Fuller please come to the AVIS rental car counter.	**Visual Paging** E. Fuller please come to AVIS counter

6. DATA COLLECTION

Technical data were collected via questionnaires and interviews with Air Canada and the Ottawa airport authority:

- Technical feasibility of displays
- Operational feasibility of displays

The survey questionnaire can be found in Appendix E.

Demonstration data were collected via questionnaires, observations, and interviews in the following scenarios with subjects:

At the gate:

Non-technology

Electronic board display

Monitor display

In terminal:

Non-technology

Display on FID monitor

Visual paging monitor

The following is a description of the actual scenarios with the technologies used during the trials. Figures 8 and 14 show the layouts of the two scenario locations. Figures 9 to 13 illustrate examples of the various screens. Figures 15 to 20 are photographs of the actual set-up.

6.1 Gate Scenarios

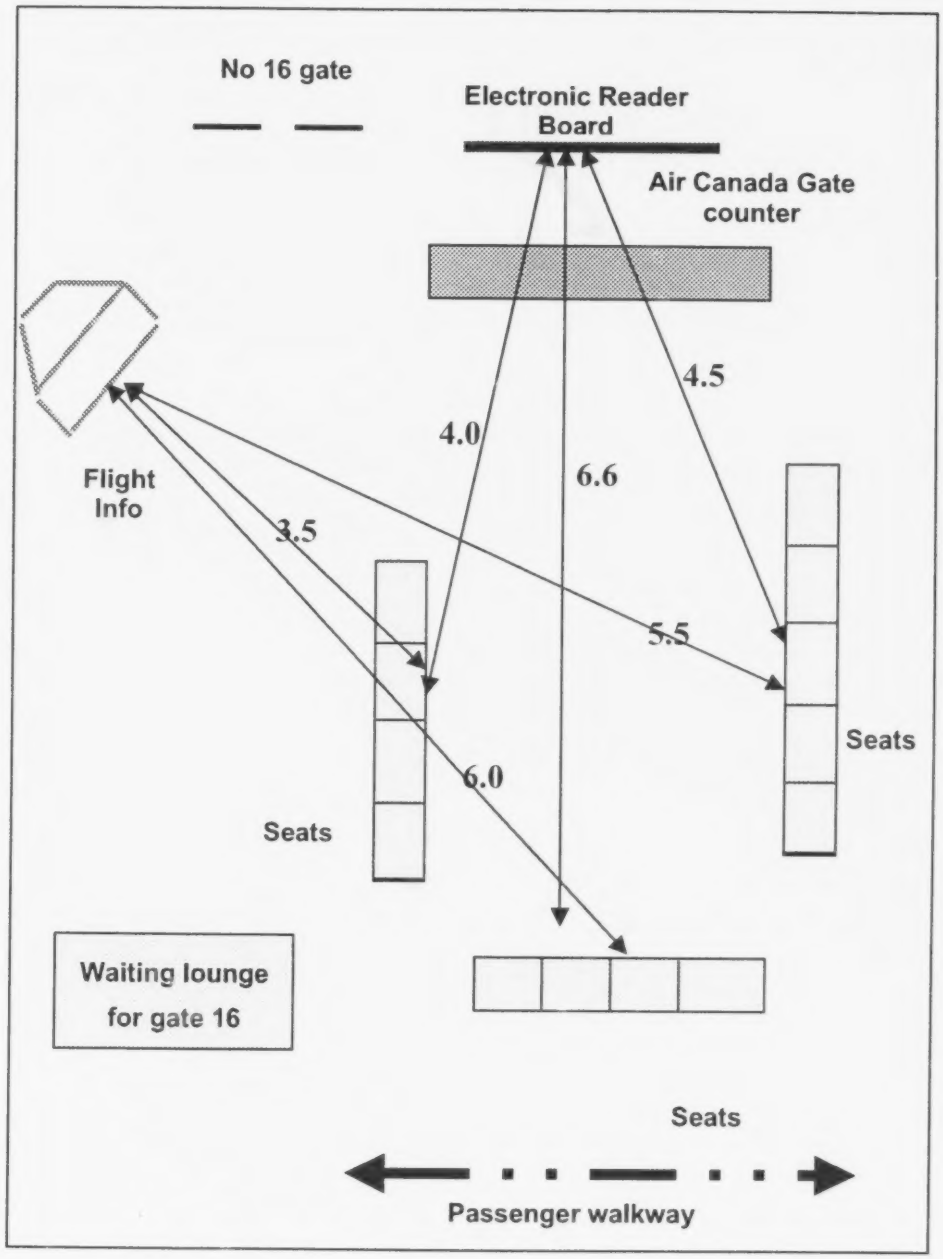

Figure 8: Layout of waiting lounge at gate 16, Air Canada, Ottawa International Airport (not to scale); dimensions in metres

Figure 9: Test set-up at gate 16, Ottawa airport

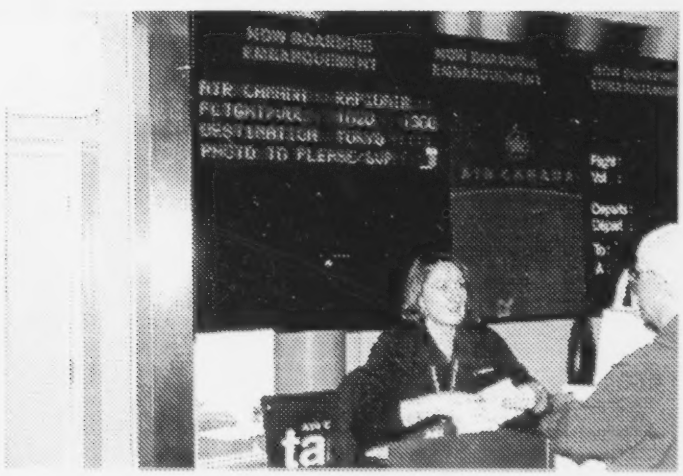

Figure 10: Non-technology demonstration

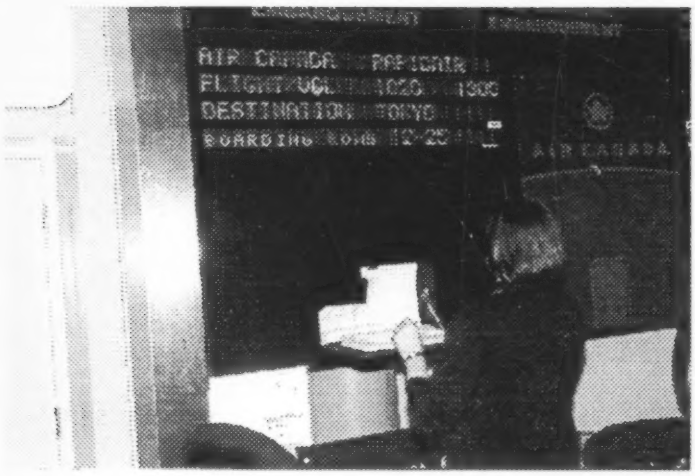

Figure 11: Electronic board display, data input by gate agent via laptop

Figure 12: Visual info monitor mock-up with text display of audio message spoken by gate agent

Figure 13: Close-up of text message shown on visual info monitor. Monitor panel showing international symbol for persons who are hearing impaired or deaf

6.2 Terminal Scenarios

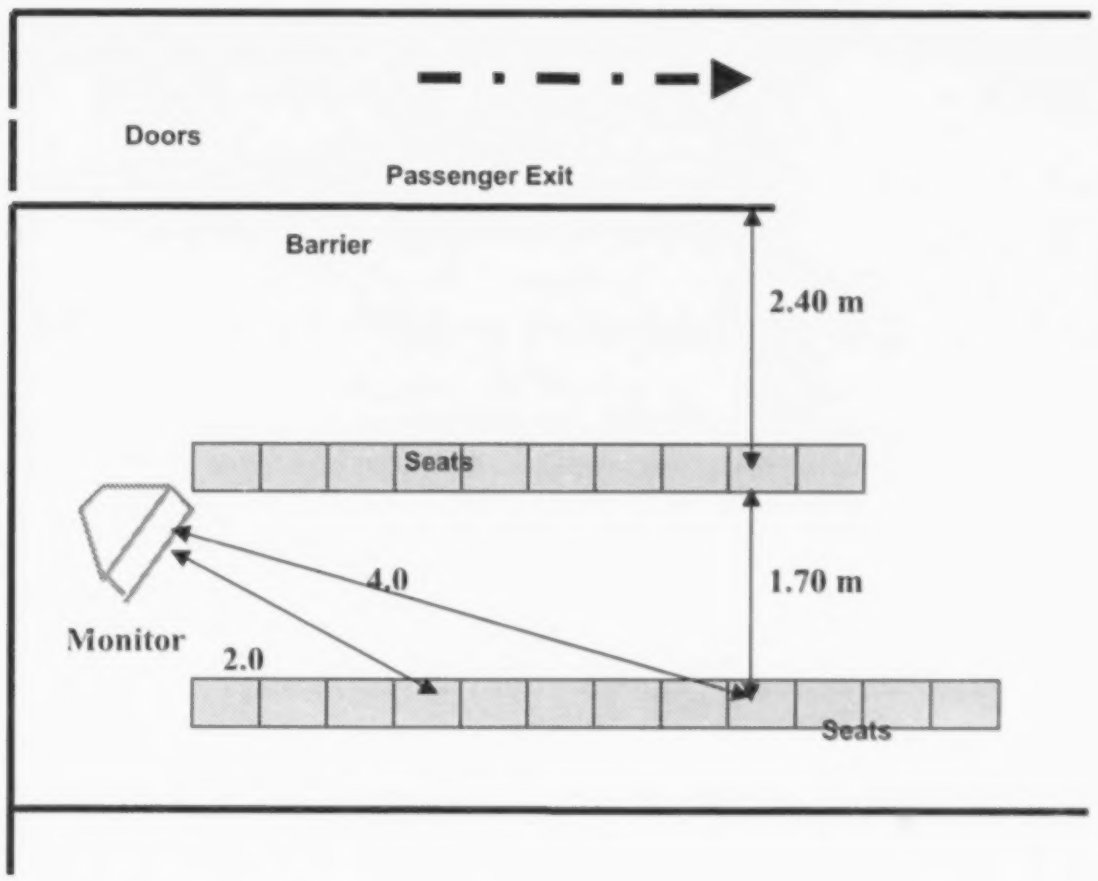

Figure 14: Layout in terminal at international arrivals waiting lounge (not to scale)

Figure 15: Non-technology, info booth agent making audio announcement over general PA system

Figure 16: Test set-up for FID monitor mock-up at waiting lounge, international arrivals, Ottawa International Airport

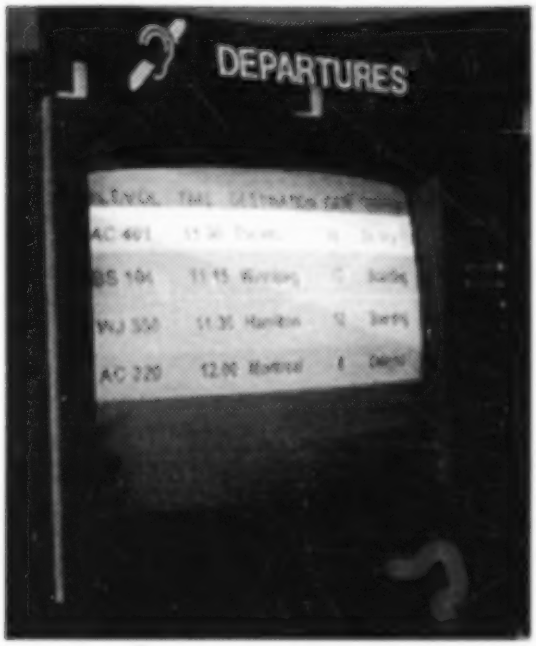

Figure 17: Close-up of departure monitor mock-up. Monitor panel shows international symbol for persons who are hearing impaired

Figure 18: Test subject reading text display on last two lines of FID monitor

Figure 19: Test set-up for visual paging monitor at international arrivals

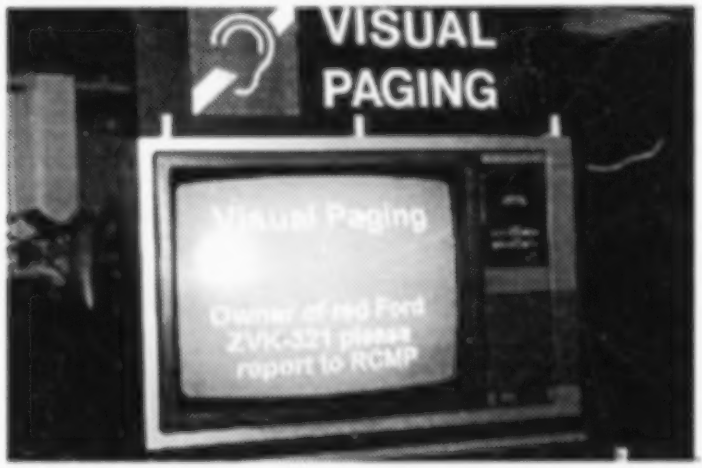

Figure 20: Mock-up of text display on visual paging monitor with the international symbol for persons who are hearing impaired or deaf

7 Results

7.1 Demographics

Nine participants were used in this experiment and were randomly selected. See Table 7 for the composition of the participants.

Table 7: Distribution of participants

PARTICIPANTS	DISABILITY
1-3	Hard of Hearing
5-7	Cognitively Disabled
8-10	Deaf

7.1.1 Use of the Ottawa airport terminal

Before the participants were exposed to the different messaging systems, basic information including familiarity with Ottawa International Airport, data on the number of times used per year, communication efficiency and problems currently encountered with respect to communication was collected.

Figure 21 shows the level of use of the Ottawa International Airport terminal facility.

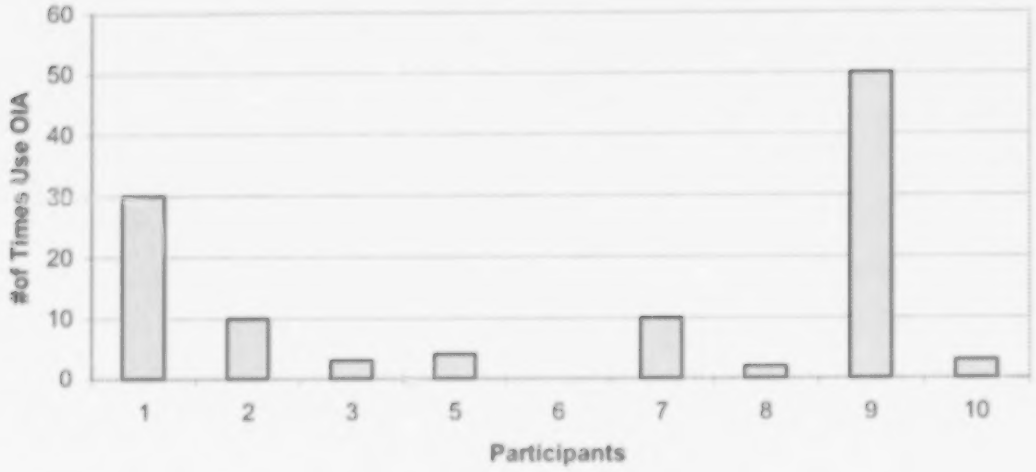

Figure 21: Use of Ottawa International Airport per year

These data indicate that some participants used the airport frequently, i.e. >10 times/year and were more familiar with Ottawa International Airport. However, all of the participants reported that they were familiar, or very familiar, with the airport terminal. Note that two individuals are high frequency fliers and are very familiar with the airport terminal. These individuals both have professions that require that they travel several times a year.

7.1.2 Pre-test perception of helpfulness of visual message displays

All participants who were tested indicated that some form of visual representation of the message would be helpful. Table 8 shows the percentage of participants who responded that they found the technology helpful.

Table 8: Pre-test perceived helpfulness of visual displays

PARTICIPANTS	Percentage
Increase confidence	83
Help to relax	83
Make flying experience more enjoyable	67

7.1.3 Difficulties encountered in the Ottawa airport terminal

The general difficulties participants have had in the past, including difficulties with the staff and current messaging systems, are listed in Table 9.

Most participants remarked that the airport staff did not adequately handle the job of communicating with passengers who have a cognitive or hearing disability since there is usually no physical evidence of these disabilities. This is an important reason for the implementation of assistive technologies, since the training of staff is limited, and their time is restricted when busy. The technologies may allow the individual with a disability to require less assistance from staff.

Table 9: Summary of participants' comments of communication difficulties

General Past Difficulties	Difficulties with Staff	Difficulties - Current Messaging Systems
• Missed flights in boarding lounge. • Unable to understand when I could board. • Didn't know of last minute gate change.	• Staff and attendants tend to cover their mouths, look away, mumble and speak to more than one person at a time. • Therefore it is difficult to speech-read.	• Messages are too long. • Some messaging systems are too fast to read and comprehend.
• Security is insensitive and unaware of devices for disabled people, i.e. FM system.	• Background noise makes it difficult to concentrate and understand (not applicable to deaf). • PA system is usually forgotten for pre-boarding and boarding therefore cannot hear clearly the up-to-date information. Poor attitude of staff when asked to repeat, rephrase.	• Difficulty reading black print on white/light grey background. • Colour of message system is very difficult to read. • Red dot matrix not good. [Minimum] four-inch character height [needed].
• For a passenger with visual and spatial problems it is difficult to find facilities, transfer between flights quickly, find parking spot, etc. • Pictographic signs with high contrasts are difficult to read, i.e. black and white (cognitive disabilities often include visual contrast problems).	• Afraid to ask for extra assistance because staff can be insensitive to non-visible disability. They can become annoyed and speak in a rude manner when asked to repeat, rephrase. • Staff don't want to or may not have time to communicate through a written format.	• Too many numbers to find my flight.
• Requests made by passenger are forgotten or ignored, i.e. not being pre-boarded or not advised of boarding in spite of request.	• Lack of training of staff, including customs officers, in handling those with non-visible disabilities. • Staff are informed of disability and it is also written on boarding pass; however, they forget and do not inform of gate change, i.e. when passenger is deaf. • Staff make assumption rather then confirm disability, i.e. bring a wheelchair when passenger was deaf.	

7.2 Human Factors of Visual Messaging Systems

The participants were asked to provide the research team with their impressions of the utility, usability and effectiveness of visual messaging technologies. They were observed as they completed each scenario, and their performance noted. The observers were looking for instances where the participants may have shown that they could not hear a message, where trying to read visual messages may have been a problem, and where messages were missed. The amount of time to respond to messages was not measured since it appeared to be a case of either seeing the message as soon as it appeared, or missing it entirely. Missing messages may have been a function of the fact that messages were not repeated often enough. Hence, most of the participants were often checking the display for information. It is likely that this behaviour would become less frequent once the participants became accustomed to the presence of improved visual messaging systems.

The scenario situation only mocked the real situation, where more visual cues would be available, such as several passengers going to the counter, lining up to board, exhibiting listening postures or appearing to be intent on finding out what was announced. These clues as to the presence of a message would likely enhance the ability of visual messaging systems to provide important information to those who may not be able to hear or understand the message delivered orally. In fact, the systems would be just as useful to all passengers who may have missed the audio message, or could not hear it clearly enough to understand what was said. The visual display would be an excellent validation of the audio message for many of the passengers, particularly when the gate area or terminal was very busy and noisy.

Furthermore, the results of this demonstration show that the technology was accepted and embraced by the participants without reservation. The participants identified many areas where the technologies could be improved, but felt that the basic concept was sound. The observations and questionnaires obtained information on readability, usability and effectiveness.

7.2.1 Level of difficulty for all technology conditions

The level of difficulty experienced by all the participants, while interacting with the different methodologies, is illustrated in Figure 22. The results demonstrated that the reader board at the gate and the visual paging in the terminal were the two methods that provided the best ease of use for the participants. It was generally reported by the participants that the current operation at Ottawa International

Airport has the potential to cause difficulties for those with disabilities. They pointed out that training of staff may be too limited, and that sometimes assistance is not available. Participants indicated that when not using any of the visual technology at the gate, they found it relatively more difficult. Their difficulties included unclear public announcements and the impact of ambient noise masking the announcements. Those with hearing aids mentioned that some external noises such as warning tones before announcements can cause irritation to their ear.

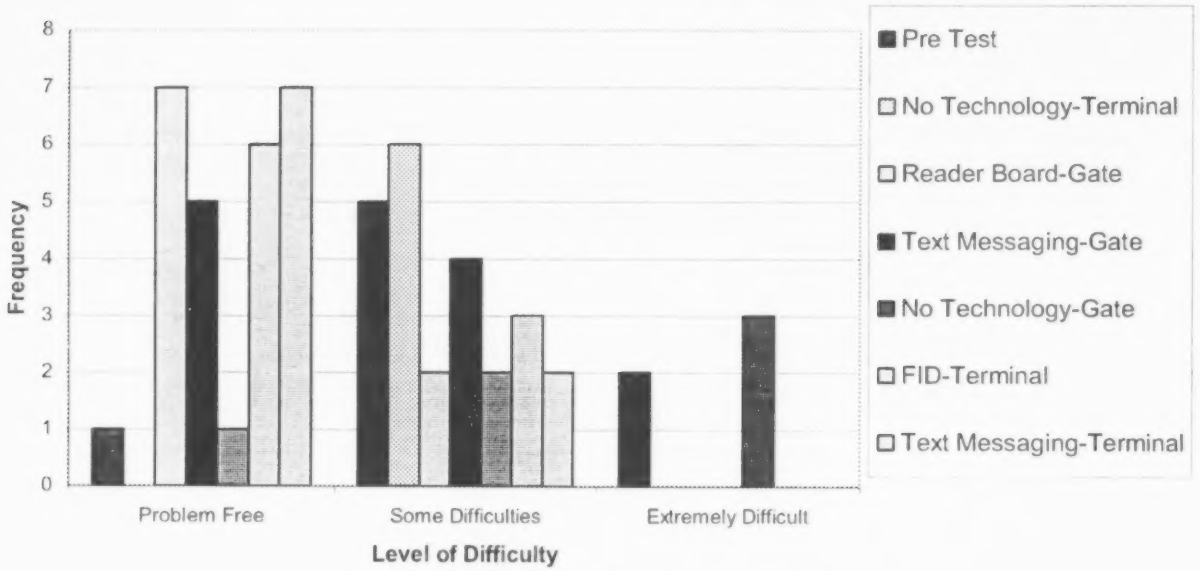

Figure 22: Experience with all methods

7.2.2 Completion of task

Participants had difficulty completing the task when technology was not used (See Table 10). The condition where there was no visual messaging technology at the gate raised the most difficulty for the participants. For all other tested methods, all participants were able to complete the tasks.

Table 10: Successful completion of the task

Messaging System	Accomplished Task (%)
No Technology-Terminal	83 *
Reader Board-Gate	100
Text Monitor-Gate	100
No Technology-Gate	32
FID-Terminal	100
Visual paging-Terminal	100

* This percentage illustrates the opinion of the participants. There were several tasks for the participants to complete and observations indicated that some of the participants did not complete the entire task but only elements of the task.

The participants who were hard of hearing did not respond to the audio messages in the terminal area. Those who were profoundly deaf did not take part in the no-technology portion of the trials in the terminal area. Since the participants were not waiting for a flight (as they were at the gate), there may have been less motivation to listen. Also, the quality of the audio transmission from the public announcement speakers in the terminal area was variable and less clear than the public announcement sound in the gate area.

Table 11 provides a summary of the participants' comments about difficulties encountered with respect to each messaging system.

Table 11: Summary of participants' comments on each technology

Messaging System	Difficulty With Each Task
No Technology-Terminal	• no personal notification when flight was cancelled • announcements made over PA caused difficulty because could not hear, distracting background noise made it difficult to concentrate, attendant was holding the phone over mouth so could not lip read and the PA did not have a personal announcement.
Reader Board-Gate	• participants felt the constant need to be watching the reader board • participants were concerned that they would miss information if they went to the washroom or looked away from the screen since the text moved quickly • some participants felt the need to sit closer to the monitor to be able to see the text
Text Monitor-Gate	• participants felt it stressful to look at the screen continuously and concentrate • participants felt that they needed to divide concentration between attendants and text messaging (i.e. different information) • the colour of the text was not completely visible form a distance • when information was given, i.e. flight cancelled, participants did not know what to do
No Technology-Gate	• could not hear everything, there was too much auditory disturbance in the background • attendants spoke too quickly • intercom not clear
FID-Terminal	• felt the need to be constantly looking at the screen • the font and background colour made it difficult to focus and understand the message, especially from a distance
Visual paging-Terminal	• the messages were not loud enough in the noisier areas • concern of missing a message • needed to move closer to message to read it

The reader board at the gate had the following problems, identified by the participants and observed by the researchers:

- Only one row was free to use for messages – two are required to accommodate both official languages;
- The letters were reddish-orange – yellow or beige would have been easier to read against the black background;
- The large bright cursor flashed annoyingly and at a rate that may be hazardous to those with epilepsy;
- The bottom portion of the board was partially hidden by staff using the computers at the counter – this is where the message was displayed;
- The message did not stay displayed long enough for some of the participants; thus they felt they needed to sit near the board and keep a constant eye on it.

The participants all indicated that they were not comfortable with the idea that they might miss a message if they were not looking at the displays all of the time. Those who were hard of hearing liked the idea of a tone to alert them to the fact that a new message is about to be announced. However, they also said that some warning tones can cause them problems, and may be painful. They suggested that tones be tested to determine which ones do not cause difficulties for people with hearing aids.

7.2.3 Level of helpfulness and readability of each technology

Figures 23 and 24 indicate how helpful each system was and how easy it was to read the message on each of the systems. These graphs illustrate that the FID in the terminal was the most helpful and participants found the FID systems in both the terminal and gate the easiest to read.

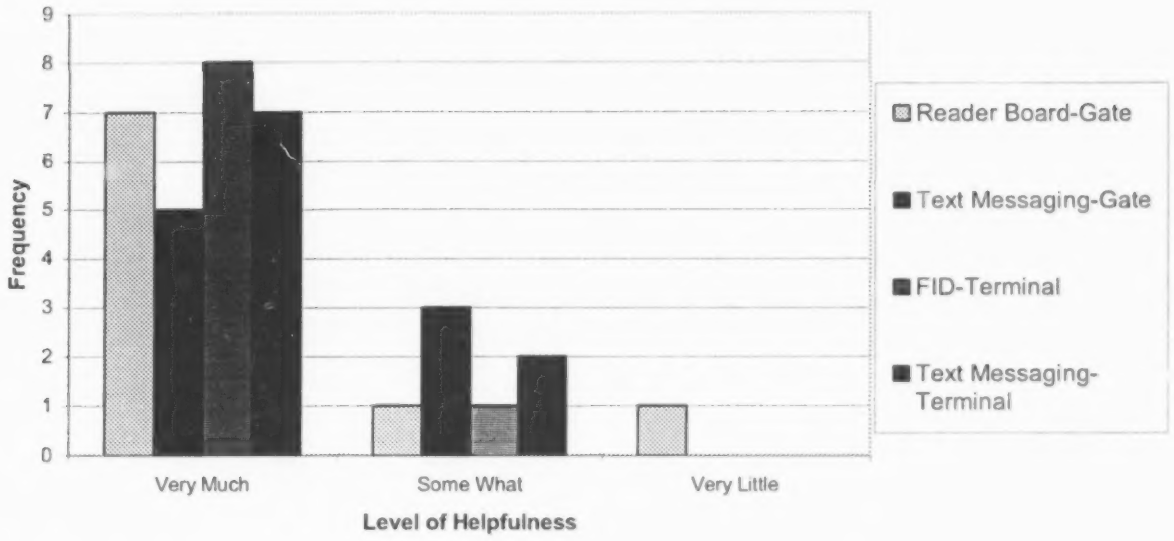

Figure 23: Summary of messaging helpfulness

The greater difficulty in reading the text monitor at the gate may be a function of its location near the reader board and other potential distractions, and the fact that it was not in the visual field of all participants sitting in the lounge area. The location of the monitors is a very important factor in their effectiveness. The placement of the monitor should be where most, if not all travellers, have the monitor in their field of view.

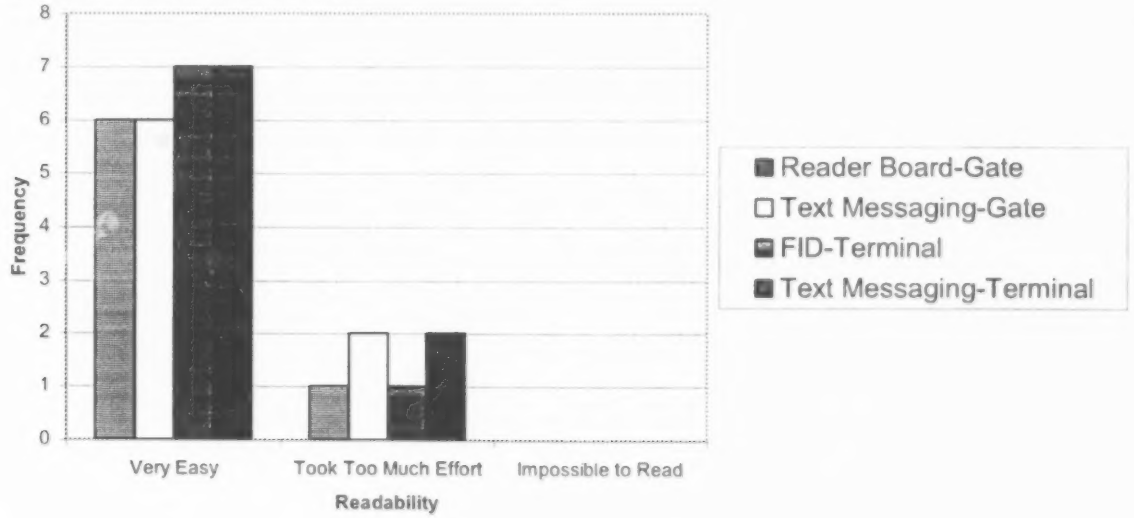

Figure 24: Level of readability for each technology

7.3 Discussion of Human Factors Results

Visual messaging can alleviate some problems faced by the travelling public, particularly those with hearing and cognitive disabilities. Increased independence and confidence will result from the knowledge that important information is present in a medium that those with hearing and cognitive disabilities can use. The demonstrations at the gate were carried out in a relatively small waiting lounge at gate 16, holding about 25 seated persons who were able to watch the display units, unimpeded, from a distance up to 5 m. It is anticipated that in much larger gate waiting lounges, and with many passengers standing, it may not be possible for passengers to have a direct view to one display unit. Several additional text display units, e.g. monitors, placed in strategically determined locations within the waiting lounge should increase the ability for many passengers to view the text display. The results of the demonstration show that there is a strong interest in visual messaging, and that the technologies tested are feasible from a usability and user-acceptance point of view. The problems encountered were technical issues that can be changed. The placement and location of the displays is critical for proper usage, and the accommodation for disabilities is equally important. Specific colour combinations for characters and backgrounds, adequate contrast, glare-free surfaces and adequate dwell times for visual messages all contribute to the level of the device's usability.

7.4 Technical Feasibility

In discussions with Air Canada at Ottawa International Airport and the Ottawa Airport Authority, the following information was provided regarding the technical feasibility of the proposed technologies.

7.4.1 Electronic reader board at gates

Currently electronic boards owned and operated by Air Canada are used at several gates at Ottawa International Airport. Black boards at gates typically have four horizontal lines, each line with 24 characters. Characters are composed of a matrix of 5 x 7 LEDs. The electronic board has a flat black background with characters shown in colours of red or orange. Input for text display is via a laptop computer that is installed at the board panel behind a lockable flip door. Currently, the first line shows "Air Canada" with "Rapidair" if applicable, the second line "Flight number" and "Departure time", the third line the "Destination airport", and the fourth line "Photo ID, please", if applicable. When several flights are leaving from the same gate, a code is programmed into the laptop for each flight, showing the complete required flight information. Each line of characters can also be composed

manually in such a way that additional information can be displayed. There is a separate laptop for data input at each gate.

7.4.2 Visual information monitors at gates

This technology is currently not available at gate counters but was mocked up to present an alternative for visual text display. It is envisioned that monitors could be used when electronic boards are not available, or in addition to electronic boards at very large gate waiting lounges to reach as many passengers as possible. One or more large video monitors with a screen of 25 to 27 in. could be installed at heights and locations where seated or standing passengers could see the display clearly. The information would be displayed in large letters on the screen and input would be via a laptop computer at the gate counter. Background colour, letter size, type and content would be designed according to human factors principles, especially for passengers with hearing disabilities, elderly passengers and those with cognitive disabilities. The information would be gate specific and could be coded accordingly for each flight. Each monitor could have the international symbol of hearing impaired persons as well as a text display, e.g. "Visual Info". All text displays would be alternated between English and French. Technically it would be feasible to apply this technology at gates.

7.4.3 Captioning on FID monitors

FID monitors are installed in all areas of the airport, in public as well as in secure areas. They provide departure and arrival flight information of all carriers operating in the airport in text format, one line for each flight. The information is keyed in and updated at a central source under the control of the airport. Only this central data centre can input data for display. Carriers, security, or any other source do not have access to this display. The information is strictly for flight data information. Technically it would be feasible to use one or two lines at the bottom of the screen for open captioning, a concept that was mocked up by the research team, but from an operational point of view does not seem feasible.

7.4.4 Visual paging

This concept is designed as a dedicated text information device to provide information on a video monitor of about 25 to 27 in. It would be a stand-alone unit located in public areas of the airport, e.g. waiting lounges, arrival and departure areas, restaurants, cafeterias, observation decks, etc. The information displayed would come from different sources that would all be connected to the visual paging system: the general info PA system, security, carriers, and the airport authority.

Similar to the present PA system, the system would be used on a first come, first served basis for data input. Each participating source would require a data input device such as a keyboard, and messages would be alternated between English and French, and repeated in sequence, until no longer valid or according to a given number of repeats. A similar system is already in place at San Diego airport.

7.5 Operational Feasibility

7.5.1 Electronic reader board at gates

Electronic reader boards are currently operated by the gate agent via a laptop computer located at each gate panel. The gate agent's duties include gate-specific oral PA flight announcements in English and French, among several other aspects. Operating the laptop to key in additional text messages does not create a problem if there are no time or labour constraints. Keying in a one-line message of a maximum of 24 characters takes approximately 15 to 20 seconds. The computer could be programmed so that the message in English is automatically translated into French and be displayed alternately. It was mentioned by gate agents that a text display in addition to the oral PA announcements could actually reduce the number of times passengers come to the counter asking for reassurance regarding flight information. Also, providing information in visual form will satisfy the concept of providing redundancy for critical information. Such a concept is common for many operations where information may be of a critical nature. This ensures that if it was missed the first time in one medium, it will likely be noticed the next time in a second medium. This is particularly true where the message conveyed by one medium is masked by noise. Of course, if individuals have a disability, only one of the mediums would be available to them.

7.5.2 Visual information monitors at gates

Visual display monitors at gates would be operated the same way as an electronic board. The gate agent would key in messages into a laptop that would be connected to one or all monitors positioned in the gate area. Messages would be translated automatically by the computer and shown alternately on the monitor screen. If a combination of an electronic board and monitor(s) were to be used, the laptop would serve both.

7.5.3 Captioning on FID monitors

From an operational point of view, the concept of displaying public information in an open captioning format on the FID monitor seems to be not feasible. For safety

and security reasons there is only one source who has access to the system to display flight data; no other participants are currently allowed to key in data.

7.5.4 Visual paging

A visual paging system would be a separate system and require that all parties in the airport who typically use the public oral PA system be connected to the visual paging system. Each party would require a data input device, and an operational protocol would have to be devised to establish rules for length of display messages, message priorities, overriding rules for emergencies, number of repeat cycles, etc.

7.6 Cost Estimates

7.6.1 Electronic board systems

This system consists of two elements: (1) the electronic board with its character display, and (2) a laptop with its software. Depending on design, size, and quantities, the cost of an electronic board can vary from about CAN$8,000 to $12,000, and the laptop between CAN$1,500 and $2,000.

7.6.2 Visual information monitors at gates

Depending on the quantity purchased, a colour video monitor with a size of about 25 to 27 in. can cost from CAN$1,200 to $1,800, not including the mounting hardware. The laptop to serve the monitor(s) can cost about CAN$2,000.

7.6.3 Visual paging unit

A visual paging unit can consist of one video monitor mounted at the ceiling, column, etc, or be a stand-alone unit with the monitor encased. The video monitor would cost approximately CAN$1,200 to $1,800 for a 25 to 27 in. monitor, not including mounting hardware. For a freestanding unit an additional cost for the casing would vary from about CAN$800 to $1,500, depending on material choice, design and quantities. These cost estimates do not include wiring, software program modifications, or labour cost.

8. CONCLUSIONS

8.1 Human Factors and Technologies

1. It was found that visual messaging systems could alleviate some specific information problems faced by the travelling public, particularly for those persons with hearing and cognitive disabilities. Increased independence and confidence could result from the knowledge that important information will be presented in a medium that is an alternative to audio.
2. At present airport/airline staff do not adequately communicate with the target group.
3. The electronic reader board at the gate and the visual paging monitor in the terminal were considered the most effective display technologies. Displays on the FID monitor in the terminal and the text monitor at the gate were considered almost as effective as the former two.
4. Participants were compelled to watch text displays, either on the reader board at the gate or on monitors in the terminal, in order not to miss information.
5. The international symbol signifying assistance for persons who are hearing impaired was placed on the monitors and found to attract the attention of persons with hearing disabilities.
6. The placement, number and location of display units is critical for effective usage. Text type, size and colour (e.g. white or yellow letters on blue or black background), glare-free surfaces and display times all contribute to the effectiveness.
7. The flashing cursor on the reader board was found distracting and annoying. The last line of the board for additional messages is located too low and can be obstructed by standing passengers or attendants.
8. Participants indicated that they should be made aware initially of the existence and the location of text display systems in the airport and at the gates.
9. The content of the displayed message should provide complete information. "Flight cancelled" left the question open of what the passenger should do.
10. The comprehension of audio messages provided over the public announcement system may depend on the announcer's voice pitch and/or speed, the environmental noise, technical qualities of the systems and airport acoustics.

8.2 Technical

1. Currently used electronic reader boards at departure gates use a technology that can easily be modified to display additional text information without any modification to the system. The display of English and French text can be achieved by alternating text between the two languages on the last line.
2. Monitors for real-time text display are currently not in use at gates or in the terminal, but the technology and input devices are available as off-the-shelf components. To set up a system at the gate, installation of monitors, hardware and software would be required. To set up a system for the terminal, it must be accessible by various participants, e.g. airlines, airport, security, information, etc.
3. Text display on Flight Information Display monitors is not feasible at present due to restrictions on their use in airports.

8.3 Operation

Electronic reader boards are operated at present by a gate agent and would require an additional 15 to 20 seconds of input time per message. The same time is anticipated for message input to monitors.

9 RECOMMENDATIONS

The following is recommended based on findings and conclusions.

- Use the reader board's last line for text display in addition to audio gate public announcements that would improve boarding information for many passengers, especially those with hearing and cognitive disabilities. Where reader boards are not available, text display on monitors may be used.
- Add the broken ear symbol to text display messages and determine size, colour and type according to international standards and ergonomic principles.
- Determine the number and location of display units at gate waiting lounges, and place them in locations free of competing visual information.
- Reduce the size of the cursor on the reader board and eliminate the flashing. Mount the reader board higher with the last line above the head height of a standing 95 percentile male. The last line must be readable from any potential viewing point within the waiting area.
- Determine the length of text display time. For text displays in a terminal, minimum display times should be determined, especially when several airport participants want to display at the same time, e.g. airlines, airport, security, information, etc.
- Promote awareness of the text display systems, i.e. airlines, airports, associations for the disabled, and other relevant media.
- Prevent ambiguous messages by displaying a complete message, e.g. "Flight is cancelled, report to agent".
- Improve the voice pitch and message speed for public announcements in terminal and at departure gates. Improve general acoustics and decrease environmental noise levels.
- Develop an in-service demonstration program in cooperation with the airlines to monitor and evaluate text displays at departure gates where reader boards are available, and use full screen text for monitors.

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Appendix A: Observation Sheet

Rhodes & Associates Inc.
Human Factors Consultants

Transport Canada Transports Canada

Visual Messaging Observation Sheet

(Location)

Participant Number: _____ **Date:** _____

Trial Number: _____ **Time of Trial:** _____

CONDITION:

☐ Gate No Technology ☐ Gate Reader Board ☐ Gate Text Monitor

Details of Situation

Environmental Conditions

Ambient light: _____ lx **Noise level:** _____ dbA

Level of passenger traffic: ☐ High ☐ Medium ☐ Low

Other environmental concerns:

_____

_____

_____

1) When <u>arriving</u> at the gate, the participant goes:

- ❑ to counter area ..... <u>does not look</u> for the messaging device
- ❑ to counter area ..... and looks for the messaging device
- ❑ to seat area and sits down ..... <u>does not look</u> for the messaging device
- ❑ to seat area and sits down ..... and looks for the messaging device

_____

_____

2) During the <u>wait period</u> the participant is:

- ❑ Relaxed
- ❑ Looks around
- ❑ Looks at display
- ❑ Queries agent
- ❑ Goes over to agent

3) At the point when the agent delivered the <u>announcement</u>, the participant:

- ▫ Looked at agent
- ▫ Looked around
- ▫ Ignored message
- ▫ Queried agent
- ▫ Goes over to agent

The participant then:

- ▫ Walks over to the boarding door
- ▫ Looks around for other clues
- ▫ Does not move
- ▫ Goes over to agent

Appendix B: Pre-test Questionnaire

Pre Test Visual Messaging Questionnaire

Participant Number: _____ **Date:** _____

Background

1) How often do you use the Ottawa airport terminal? _____ times per year.

2) How familiar would you say you are with the terminal?

☐ Very much ☐ Somewhat ☐ Very little

3) What assistance or assistive device do you typically use when you want to communicate with airport staff:

☐ I/R Loop ☐ Pencil-Paper ☐ Other _____

_____

4) If you have traveled by air in the past, departing from Ottawa airport, please rate your general communication/information experience as a passenger using the Ottawa airport terminal facilities:

☐ Problem free ☐ Some difficulties ☐ Extremely difficult

5) Please describe any difficulties you have experienced in the past.

_____

_____

_____

_____

_____

6) Have you seen changeable text message displays, e.g. Flight Departure and Arrival Messages? ☐ No ☐ Yes

NOTE: *Changeable Text message displays use changing messages to provide up-to-the-minute flight or related passenger information*

7) Were such displays helpful? ☐ No ☐ Yes

8) Did you encounter any problems while using changeable text message signs? ☐ No ☐ Yes

9) Describe any problems you encountered while using changeable text message signs?

_____
_____
_____
_____
_____

10) Describe any difficulties you have experienced at communicating with staff at airports.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix C: Post-test Questionnaires

Post Test Visual Messaging Questionnaire

No Technology – (Location)

Participant Number: _____ **Date:** _____

Trial Number: _____ **Time of Trial:** _____

Experience During Trial

1) Were you able to accomplish the task you were given?

☐ No ☐ Yes

2) Please rate your general experience during this trial:

☐ Problem free ☐ Some difficulties ☐ Extremely difficult

3) Please describe any difficulties you experienced during this trial.

_____
_____
_____
_____
_____

4) What do you think would help reduce or eliminate any difficulties?

☐ Being able to see the message ☐ Having staff come and assist me

☐ Other: (please tell us)_____

5) If you were provided with a visual representation of the message, would this be helpful?

☐ No ☐ Yes

6) If the message was available in text form on a display, how would this affect you? (check as many as apply)

☐ Increase my confidence ☐ Help me relax

☐ Make my flying experience more enjoyable

Thank you for your help with this important study. The results of this work will be shared with the airport authorities, airlines and equipment manufacturers.

Post Test Visual Messaging Questionnaire

(Name of area and technology test condition)

Participant Number: _____ **Date:** _____

Trial Number: _____ **Time of Trial:** _____

Experience during the trial

1) Were you able to accomplish the task you were given?

☐ No ☐ Yes

2) Please rate your general experience during this trial:

☐ Problem free ☐ Some difficulties ☐ Extremely difficult

3) Please describe any difficulties you experienced during this trial.

_____
_____
_____
_____
_____

4) What do you think would help reduce or eliminate any difficulties?

☐ Being alerted to the message
☐ Having staff come and assist me
☐ Other: (please tell us)_____

5) Did you use the (TYPE) monitor (the text message device)?

☐ No ☐ Yes

(TYPE) Post Test Questionnaire continued

Participant Number: _____ **Date:** _____

Trial Number: _____ **Time of Trial:** _____

6) What prompted you to use the text message device?

- ☐ Happen to notice it
- ☐ Looked for it because I couldn't hear the message
- ☐ Noticed others looking at it

7) If the text message device was visible, and you DID NOT use it, please tell us why you didn't use it.

_____

_____

_____

_____

_____

8) If the text message device was visible, and you DID use it, was it helpful?

☐ No ☐ Yes

9) How helpful would you say the message was?

☐ Very much ☐ Somewhat ☐ Very little

10) Please indicate how easy it was to read the message on the device:

☐ Very easy ☐ Took to much effort ☐ It was impossible to read

(TYPE) Post Test Questionnaire continued

Participant Number: _____ **Date:** _____

Trial Number: _____ **Time of Trial:** _____

11) Do you remember what the message said? Please write, in the space provided, generally what the message said?

_____
_____
_____
_____
_____

12) If reading the device was difficult or impossible, please indicate why this may have happened.

_____
_____
_____
_____
_____

13) Please describe any other difficulties you may have experienced while using the message device.

_____
_____
_____
_____
_____

Thank you for your help with this important study. The results of this work will be shared with the airport authorities, airlines and equipment manufacturers.

Appendix D: Ergonomics Checklist

Visual Messaging Human Factors Checklist

Criterion	Yes	No	Nature of Non-conformance
1. Reader Boards			
a) Contrast ratio of characters to background is adequate (~70%)			
b) Characters are yellow, white, or beige on a dark background			
c) Ambient light is between 100 and 300 lux			
d) Character size is adequate for expected maximum distance from observer (e.g. 20 cm for 6 m)			
e) Glare sources that may interfere with the board are absent			
f) Viewing angle is within the comfortable range for a seated individual			
g) Message is displayed for an adequate period of time			
h) Minimum dot matrix is 7 X 9			
i) Dot-pitch at least 6 mm			
j) Lighted characters do not produce a glare source			
k) Backboard is free of glare			
l) Nothing is blocking the view of the reader board			
m) Board is readable from a low sitting position			
n) Ambient noise level is below 85 dbA			
o) Redundant sound with visual alert			
2. Monitors			
a) Monitor refresh rate does not produce flicker			
b) Screen surface does not produce glare			
c) Character/background contrast is adequate			

Visual Messaging Human Factors Checklist continued

Criterion	Yes	No	Nature of Non-conformance
d) Characters are yellow, white, or beige on a dark background			
e) Character size is adequate for expected maximum distance from observer (e.g. 20 cm for 6 m)			
f) Ambient light is between 100 and 300 lux			
g) Glare sources that may interfere with the monitor are absent			
h) Viewing angle is within the comfortable range for a seated individual			
i) Message is displayed for an adequate period of time			
j) Monitor can be viewed from a low sitting position			
k) Nothing is blocking the view of the monitor			

Appendix E: Technology Survey

Visual Messaging Systems

A. Questionnaire – Technical

GATE – ELECTRONIC BOARD

1. Contact:.....
2. Company.....
3. Date.....
4. Electronic reader boards are in place at some gates at Ottawa International Airport. The gate agent for flight related data input shown on the board uses a laptop.
5. Can last line of electronic board (24 characters, matrix 5x7) be made available for real time text information in English and French?

   YES ☐ NO ☐

6. How would each language appear?
   - Alternate English and French .....
   - Line half English, half French (message would be very limited)?.....
7. Real time data input via laptop at gate by agent? YES ☐ NO ☐
8. Real time input by other device?.....

B. Questionnaire – Technical

GATE – MONITOR

1. Monitors are presently not in place at gate counters at Ottawa International Airport. In some airports they are used instead of an electronic boards (e.g. Toronto and some US airports).
2. If monitor(s) would be in place at the gates <u>in addition to the reader board</u> would real time data input be made by gate agent via a laptop, providing input to both?

   YES ☐ NO ☐

3. If NO, what would be required?.....

4. If only monitor(s) would be in place at the gates, would gate agent via a laptop make real-time data input?

   YES □ NO □

5. What would be used for data input?.....

C. Questionnaire – Technical

TERMINAL – FIDs MONITOR

1. Can FIDs monitors (arrivals and departures) technically be used for displaying text messages on lower two lines of screen?

   YES □ NO □.....

2. If YES, can one line be for English, another be for French, or would languages alternate? .....

3. Can background colour and text colour on lower two lines be customized? YES □ NO □

4. Can display time of message be customized? YES □ NO □

D. Questionnaire – Technical

TERMINAL – VISUAL PAGING MONITOR

1. Could a visual paging monitor system (several monitors as stand alone units in specific areas in public areas of the terminal) be installed, and data fed into the system from several sources (e.g. carriers, airport, security, info booth)?

   YES □ NO□ ... ...

2. Would airport install the system?

   YES □ NO □.....